

STANDARD OPERATING PROCEDURE

FOR

ROUTINE OPERATION OF THE

MET ONE MODEL 1020 BETA ATTENUATION

MONITOR

FOR PARTICULATE MATTER MASS IN CRPAQS

STI-999214

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TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
1. SCOPE AND APPLICABILITY	4
2. SUMMARY OF METHOD	4
3. DEFINITIONS.....	4
4. HEALTH & SAFETY WARNINGS	5
5. CAUTIONS	5
6. INTERFERENCES	5
7. PERSONNEL QUALIFICATIONS	5
8. APPARATUS & MATERIALS	5
9. SITE & EQUIPMENT PREPARATION	7
10. INSTRUMENT OR METHOD CALIBRATION	9
10.1 Flow Calibration.....	9
10.1.1 Flow Calibration Procedure	9
10.2 Membrane Calibration Check	10
10.2.1 Record the Last Calibration Measurement on Instrument Screen.....	11
10.3 Automatic Zero Testing	11
11. SAMPLE COLLECTION OR INSTRUMENT OPERATION	12
12. HANDLING & PRESERVATION OF SAMPLES	13
13. SAMPLE PREPARATION	13
14. PREVENTIVE MAINTENANCE & REPAIRS	13
14.1 Changing the filter tape	13
14.2 Flow audits using the BIOS flowmeter	14
14.3 Check water/particulate loading in the cyclones.....	15
15. TROUBLESHOOTING	15
16. DATA ACQUISITION, CALCULATIONS, AND DATA REDUCTION.....	16
17. COMPUTER HARDWARE & SOFTWARE.....	17

18. DATA MANAGEMENT & RECORDS MANAGEMENT	17
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LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
Task Figure 1. Example of a typical data report from the RS-232 port.....	20
Task Figure 2. Successful SELF TEST results	24

LIST OF TABLES

<u>Table</u>	<u>Page</u>
Table 3. ABS values for each of the Met One BAM 1020 instruments	11
Table 1. Regular maintenance procedures and timing required for the Met One BAM.....	13
Task Table 2. Error codes for the Met One BAM data output from the RS-232 port.....	16
Task Table 1: Met One BAM 1020 Quick Reference Sheet.....	18
Task Table 2. Error codes for the Met One BAM data output from the RS-232 port	21
Task Table 3. ABS values for each of the Met One BAM 1020 instruments.....	22

1. SCOPE AND APPLICABILITY

The Met One Model 1020 BAM automatically measures and records dust concentrations with built-in data logging. The principle of beta absorption is used to provide a simple determination of mass concentration. An energy source of beta particles produces repeatable measurement characteristics. Glass fiber filter tape is used to provide lengthy periods of monitoring without operator intervention.

2. SUMMARY OF METHOD

The Met One BAM 1020 collects particles by pulling a measured volume of ambient air through the filter paper. In operation, the Beta detector counts the number of Beta particles passing through the filter paper before and after the filter paper collects particulate matter. A known amount of electron scattering and attenuation through a clean filter is compared with that of a dust-sampled filter. To calculate mass concentration, a ratio of the number of detected beta particles passing through the filter and the sample volume is used.

The radioactive carbon 14 Beta source has been selected to match the energy of the Beta spectrum to the mass to be measured. The carbon 14 Beta source has a long half-life of 5,700 years, which translates to a constant level of energy without other spectral emissions.

3. DEFINITIONS

Words written in all capital letters refer to menu options or labels on the instrument.

BAM = Beta Attenuation Mass Monitor

Password = F1 F2 F3 F4

Two manuals are available; release dates of 22 August 1999 and 1 November 1999. Throughout this SOP the operator is referred to various manual sections for additional information. Sections found in the 22 August 1999 manual have an "o" suffix indicating the old manual, while sections found in the 1 November 1999 manual have a "n" suffix indicating the new manual (e.g., section o9.2 refers to section 9.2 of the 22 August 1999 manual, while n9.2 refers to section 9.2 of the 1 November 1999 manual). References to the manuals are separated by a "/" (i.e., Refer to section o9.2/n4.7 of the manual for instruction on how to load the tape).

4. HEALTH & SAFETY WARNINGS

Do not remove the cover from the instrument without first disconnecting the power. Do not detach the cover from the Beta source. Removing the cover will expose the operator to radiation.

5. CAUTIONS

Instrument calibration is established at the factory, do not change the calibration information without information from the factory regarding new settings. Some of the setup functions relate to system calibration. These functions are marked with an '*'. Do not attempt any adjustment of these functions. If they are changed in error, consult the setup parameter record for this unit located in Appendix B of the manual.

6. INTERFERENCES

There are no interference problems specific to this instrument. As with all ambient sampling, instrument siting must be carefully considered to avoid interference.

7. PERSONNEL QUALIFICATIONS

No special training is required to operate this instrument.

8. APPARATUS & MATERIALS

- The inlet of the Met One BAM 1020 consists of a long ½" ID pipe with two possible inlet configurations. Either the Met One BAM 1020 will have a PM₁₀ filter configuration or a PM₁₀ / PM_{2.5} configuration at the inlet. The inlet must be mounted directly through the roof of the building in which the Met One BAM 1020 is placed. Mounting hardware for the roof is included.

SOP: Met One BAM 1020

Revision: 4.1 (MM)

Date: October 26, 2000

- A length of 3/8" tubing must be run from the outlet of the Met One BAM 1020 to the inlet of the pump.
- The pump is controlled by an analog signal from the Met One BAM 1020. The included wire must be attached to the analog output on the rear of the Met One BAM 1020 labeled PUMP CONTROL. The configuration of the two wires is irrelevant.
- Filter paper tape is used for sampling and must be changed approximately every 2 months.
- A standard screwdriver is required to make the analog connections.
- A flow audit adapter is required to audit the flows on the instrument.
- A thermometer and barometer are required to record ambient conditions for the flow audit.

An exhaustive list of materials needed for Met One BAM setup, routine operation, auditing, and takedown are as follows:

EQUIPMENT: Met One BAM				
ITEM:	COMPONENT:	MANUFACTURER	S/N	#
Analog cable for pump control	BAM	Met One Instruments		1 ea. per inst.
BAM Model 1020	BAM	Met One Instruments		1 or 2
CRPAQS DAS or Laptop	BAM	various		
Extension cords, 25 '	BAM	Met One Instruments		1-2 ea. per inst.
External pump	BAM	Gast	# 0623-101Q-G582DY	1 ea. per inst.
For PM 10: PM 10 inlet	BAM	Met One Instruments		1 ea.
For PM 2.5: Both PM10 & 2.5 cyclone	BAM	Met One Instruments		1 ea.
Inlet extension tubing, 6' or 8'	BAM	Met One Instruments		1 ea. per inst.
Instrument manual	BAM	Met One Instruments		
Pallet	BAM			1
plywood	BAM			1 sheet
Roof flange, 1 & 1/16" ID	BAM	Met One Instruments		1 ea. per inst.
Roof flange, 1-1/4"	BAM	Met One Instruments		1 ea. per inst.
RS232 cables/adapters	BAM	Met One Instruments		25'
STI SOP	BAM			
Surge protector strip	BAM	Met One Instruments		1-2 ea. per inst.
Tripod	BAM	Met One Instruments		1 ea.
Vacuum grease	BAM	Met One Instruments		1 tube
Vinyl tubing, Reinforced 3/8" OD x 1/4" ID	BAM	Met One Instruments		25'
**items needed for initial checks				
Barometer	cal / setup tests			1
BIOS, 1-40 LPM and assorted tubing	cal / setup tests			1
Calculator	cal / setup tests			1
Flow Audit adapter and tubing	cal / setup tests	Met One		1
Instrument manual	cal / setup tests	Met One		
Laptop (remote sites) or CRPAQS DAS	cal / setup tests			1
STI SOP	cal / setup tests			1
Thermometer	cal / setup tests			1
Timepiece set to DAS	cal / setup tests			1
Worksheets, Tasks 1-5	cal / setup tests			5-10 ea.

**items to leave at site				
Filter tape	consumables	Sibita	8018062	1 per inst.
Instrument manual	consumables	Met One		
Field Logbook, Instrument Specific	consumables			1 per inst.
Tools needed:				
Rover toolbox, and:				
assorted cable ties				
assorted screws, philips, wood 1/2 to 1-1/2 "				
assorted sockets				
assorted various nuts, bolts, washers				
Drill, assorted bits				
hacksaw				
Hole saw, 4 " or 1-1/4"				
level				
pipe cutter				
plumbers tape				
Power cords				
Sawsall w/ blades				
silicone and gun				
Swabs				
teflon tape, 1 roll				
Vinyl gloves, non-powdered				
voltmeter				

9. SITE & EQUIPMENT PREPARATION

- Off site equipment acceptance
 - Check for any visible equipment damage.
 - Make sure all of the parts and options ordered are included.
- Off site pre-deployment equipment test
 - Connect the desired sampling inlet filter (PM₁₀ or PM₁₀ / PM_{2.5}) to the top of the instrument.
 - Attach the included wire for the analog communication between the Met One BAM 1020 and the pump at the location labeled PUMP CONTROL on the back of the Met One BAM 1020. Caution: the pump should be unplugged before the analog communication wire is connected or a shock may result. Attach the analog communication wire to the pump with use of a flat screwdriver. The configuration of the two wires doesn't matter.
 - Plug the Met One BAM 1020 into a 120 VAC outlet and turn on the instrument (switch is on the back).
 - Attach the 3/8" tubing to the back of the Met One BAM 1020 at the location labeled VACUUM. Push the hose into the VACUUM port until the hose can not be removed by pulling (to remove the hose the collar must be depressed).
 - Attach 3/8" tubing to the pump in the same matter.

- The filter tape must be loaded. Refer to Section 14.1 of this document or Section o9.2/n4.7 of the instrument manual for instruction on how to load the tape.
- Verify that the time and date are correct on the MAIN MENU screen. If not, press SETUP, choose CLOCK by pressing SELECT, use the right arrow key to move the cursor, and the up-and-down arrow keys to change the time or date. Press SAVE to enter the correct date and time. Press the EXIT soft-key to return to the MAIN MENU. Verify on the MAIN MENU screen that the time and date are correct.
- From the SETUP menu, go to the submenu SAMPLE, enter the password (The password is F1 F2 F3 F4.). Verify that the RS-232 is configured to 9600 N 8 1 and that the Met One BAM 1020 SAMPLE is 50 MIN. If a value needs to be changed move the cursor with use the right arrow button and the up-and-down arrow keys to change the value. Save the changes by pressing SAVE. Press the EXIT soft-key to return to the MAIN MENU.
- After verifying that the tape is loaded, the sample inlet is connected, and the setup parameters are correct, start up the measurement cycle.
- Press the OPERATE soft-key on the MAIN MENU to enter the OPERATE menu. Verify that the OPMODE is "ON". If it is not already on, press the up cursor to turn the OPMODE "ON". Press the EXIT soft-key to return to the MAIN MENU.
- Allow the instrument to operate for several days.
- Perform a flow audit as described in Section 14.2.
- Check the last reference membrane measurement, as described in Section 10.2.1.
- On-site equipment acceptance
 - The same procedure should be followed on-site as was followed off-site.
- On-site equipment installation
 - A hole must be sawed in the ceiling of the equipment building to accommodate the inlet of the Met One BAM 1020.
 - The Met One BAM 1020 inlet should be at minimum 4 feet from any other inlet.
- On-site connection of equipment to the data acquisition system
 - The Met One BAM 1020 has an RS-232 port, located on the back of the instrument that is used to monitor instrument status and collect data.
 - The Met One BAM 1020 RS-232 has a switch to all allow it to communicate using either a straight-through or null modem serial cable.
 - If a straight-through cable is used, the switch must be in the reverse position. If a null modem serial cable is used, the switch must be in the normal position.
- On-site connection of equipment to calibration system
 - The Met One BAM 1020 is not connected to the calibration system.

- On-site equipment test
 - The same procedure should be followed on-site as was followed off-site.

10. INSTRUMENT OR METHOD CALIBRATION

Three methods of calibration are performed on the Met One BAM 1020, one of which require an operator. The flow system field calibration requires the use of a calibrated flowmeter (such as a BIOS DryCal), a barometer, and a thermometer as described in Section 10.1. A flow calibration should only be performed after a flow audit, described in Section 12.2, has failed. Automatic concentration calibration checks are performed during every measurement cycle and are described in Section 10.2. Section 10.2 is important to read because the calibration checks have been modified for CRPAQS. To ensure the consistency of the measurement system, zero checks are performed during every measurement cycle. The automatic zero checks are described in Section 10.3.

10.1 FLOW CALIBRATION

If the flow audit procedure, described in Section 12.2, reveals that the mass flow controller is off by more than 10%, a flow system calibration should be performed. Before performing the flow calibration, report the problem to the field manager.

10.1.1 Flow calibration procedure

- Change Cv and Qo to 1.0000 and 0.0000, respectively. These values are found by entering the soft-keys in the following sequence: MAIN MENU, SETUP, and SELECT CALIBRATE. Left-and-right arrow keys move the cursor and up-and-down arrow keys change the value. Once into the calibrate screen, change the Cv value to 1.0000 and the Qo value to 0.0000. Press the SAVE and EXIT soft-keys to save the values and exit the screen.
- Record the ambient temperature Ta in Kelvin with an external thermometer and the pressure Pa in mm Hg (760 mm Hg = 1013 mbar).
- Cycle the filter tape to a new location. From the MAIN MENU press the TEST, select Met One BAM 1020, select TAPE, and press FWD soft-keys.
- Disconnect the pump tubing from the back of the Met One BAM 1020.
- Lower the nozzle and turn on the pump. From the MAIN MENU, press the TEST, select Met One BAM 1020, select PUMP, and PUMP ON soft-keys. No air should be flowing though the Met One BAM 1020. Record the flowrate as zero flow Zf in liters per minute.

- Set Q_o to the negative of the zero flow ($-Z_f$). From the MAIN MENU, press the SETUP and select CALIBRATE soft-keys. Save values and exit screen by pressing the SAVE and EXIT soft-keys.
- Reconnect the pump vacuum line to the Met One BAM 1020 and remove the inlet pipe with the PM10 inlet. Attach the short inlet pipe to the Met One BAM 1020 along with a calibrated flowmeter using a flow audit adapter.
- From the MAIN MENU, press the TEST, select BAM, select PUMP, and PUMP ON soft-keys to turn on the pump.
- Wait at least 5 minutes and record the flow Q_a indicated by the BIOS DryCal calibrated flowmeter in liters per minute. Also, record the flow as indicated by the Met One BAM 1020 Q_b in liters per minute.

Find Q_s where $Q_s = Q_a * (P_a / T_a) * (298 \text{ K} / 760 \text{ mmHg})$

Find C_v where $C_v = (Q_s - Z_f) / Q_b$

Find Q_o where $Q_o = -C_v * Z_f$

- Change C_v and Q_o . From the MAIN MENU, press the SETUP and select CALIBRATE soft-keys. Using the cursor arrow, change C_v and Q_o to the values calculated above.
- Turn Met One BAM 1020 pump on and compare the calibrated flowmeter value Q_a to the flow indicated by the Met One BAM 1020 Q_b . Redo the calibration if the values are not within 1%.

10.2 MEMBRANE CALIBRATION CHECK

The Met One BAM 1020 has a built-in calibration check for the Beta source. During every sample period, the calibration membrane is inserted into the Beta pathway to determine the 'mass' of the membrane. Each membrane has a calculated mass, which is stored in the Met One BAM 1020 memory under the name ABS. Whenever the membrane calibration is performed, the computed value is compared to the stored value to evaluate instrument operation. If the instrument fails to perform to specification ($\pm 3\%$ according to Section 04.7/n4.16.1), an error is logged in memory and the data is flagged with a D (deviant membrane density) indicating that the reference membrane is out of limits by the above specification.

The reference membrane used in CRPAQS has a much lower absorption than the standard membrane used in the Met One BAM 1020. The Met One BAM 1020 standard membrane has an absorption equivalent to approximately 1000 mg/cm^2 , whereas the membranes used in CRPAQS have absorption values equivalent to approximately 200 mg/cm^2 . The less absorbing reference membrane is desirable because 200 mg/cm^2 is closer to the maximum concentration typically observed in the ambient air. As a result of this change, the tolerance specification is much more stringent. A 3% tolerance specification on the measurement of the 1000 mg/cm^2 membrane translates to $\pm 30 \text{ mg/cm}^2$ ($3\% * 1000 \text{ mg/cm}^2$). A 3% tolerance specification on the measurement of the 200 mg/cm^2 membrane translates to only $\pm 6 \text{ mg/cm}^2$.

Therefore, the specification is often not met and calibration errors are commonly logged in the data.

The exact value of the measurement is not the most important issue. Instead, the measurement must be consistent over time to ensure that there is not a problem with the concentration measurement. The operator should regularly check (included in the weekly data sheet) the last measured reference membrane value and make sure that the values do not show an increasing/decreasing trend.

10.2.1 Record the last calibration measurement on instrument screen

To view the last calibration value, from the main menu, press the OPERATE soft-key. The operate menu should be displayed. Press the NORMAL soft-key from this menu to view the current flowrate (FLOW). The last measured reference membrane (LAST m) value is also displayed on this screen. Record these values on the data sheet. Press the EXIT soft-key twice to first return to the operating menu and next to return to the main menu. The values should be within $\pm 10\%$ of the ABS value for that instrument. The ABS values for each of the instruments is listed below according to the STI CRPAQS serial number on the front of the instrument.

Table 3. ABS values for each of the Met One BAM 1020 instruments

STI CRPAQS number	ABS value	Acceptable Range for last m value
009	0.188	0.169-0.207 mg/cm ²
010	0.173	0.156-0.190 mg/cm ²
024	0.186	0.167-0.205 mg/cm ²
027	0.162	0.146-0.178 mg/cm ²
028	0.217	0.195-239 mg/cm ²

If the values are not within the acceptable range, call Nicole Hyslop (707-665-9900) or Beth Wittig (661-837-4219).

10.3 AUTOMATIC ZERO TESTING

Zero testing of blank filter paper is performed at the beginning and end of each sample period to ensure the stability of the measurement system. Zero testing is based on the ability of the Met One BAM 1020 to hold a constant output when measuring blank filter paper. If the difference between the two values exceeds a preset limit, a data error message is logged in memory and the data value is flagged.

11. SAMPLE COLLECTION OR INSTRUMENT OPERATION

The sampling time must be set between 5 and 50 minutes. The lower limit is to allow the auto-calibration to occur, and the upper limit is to allow a sample to be taken every hour. During CRPAQS, a sampling time of 50 minutes will be used. This is the default time and is saved when power is cycled.

To begin sampling, press OPERATE on the main menu to enter operate mode. The operate menu has four options, NORMAL is the standard monitoring mode. Verify that the "OPMODE" is "ON". Use the UP cursor to turn OPMODE on and the DOWN cursor to turn OPMODE off. When the Met One BAM 1020 is placed in the operate mode, it will continuously operate until it is commanded to stop. The command to stop may be generated by the operator selecting OPMODE = OFF, by the operator attempting to use either SETUP or TEST while the Met One BAM 1020 is in operation, or by the Met One BAM 1020 after a non-correctable fault has been encountered (such as broken tape).

NOTE: The LCD screen of the Met One BAM 1020 will not operate when communications over the RS-232 line are in process. If the operator is using the Met One BAM 1020 locally and the display is in one of the sub-menus, the RS-232 data line is disabled. Therefore, the Met One BAM 1020 must be left in the main menu when RS-232 communications are expected.

Each measurement cycle begins at the top of the hour according to the time on the instrument clock. A cycle contains the following steps. Each cycle begins with an initial count of the clean filter tape, the symbol I0 appears on the screen. This measurement takes 4 minutes. Next, the filter tape is moved 4 windows, and the sampling begins on the section of tape where I0 was just measured. The sampling period is defined by the inlet nozzle being lowered down to the surface of the filter paper and the vacuum pump turning on. Air is drawn through the small spot on the filter tape for 50 minutes. At the same time, the second count occurs, the symbol I1 appears on the screen. The I1 count occurs at a spot on the filter tape 4 windows over for a period of 4 minutes. This measurement compensates for instrument drift caused by varying external parameters such as temperature and relative humidity. Next, the third count occurs with the reference membrane extended over the tape, the symbol I2 appears on the screen. This measurement ensures that the instrument is making consistent measurements of a reference membrane. When the sampling period ends, the tape is moved back 4 windows to count the dusty section. This is considered count I3, and I3 appears on the screen. Finally, the concentration calculation is performed to complete the cycle. The new cycle begins at the next appropriate hour mark.

12. HANDLING & PRESERVATION OF SAMPLES

The used sampling tape will be discarded. No further analyses can be performed on the tape because it is automatically rolled up after use.

13. SAMPLE PREPARATION

The unused filter tape must be stored in a dry place. The tape should be stored in its original packaging until ready to use to avoid contaminating the tape with dirt.

14. PREVENTIVE MAINTENANCE & REPAIRS

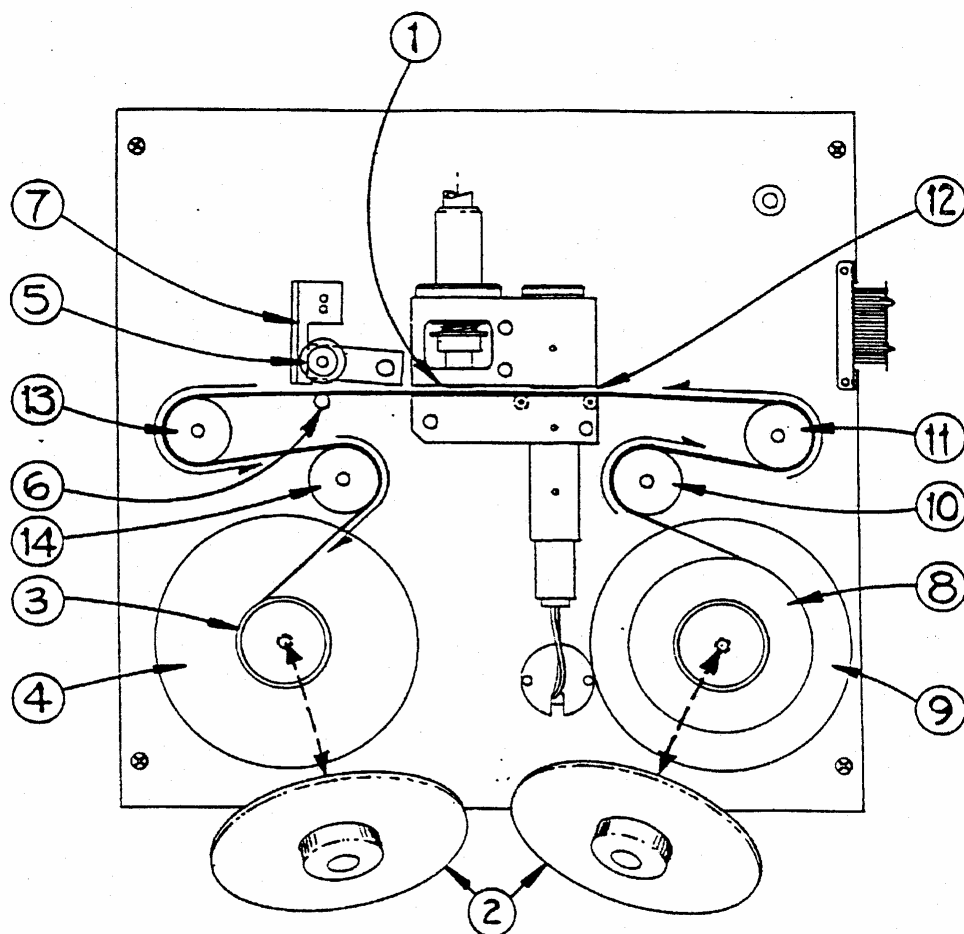
Detailed descriptions of the regular maintenance can be found at the end of this SOP. A Quick Reference Guide has been developed for the Met One BAM 1020 for use in the CRPAQS field project. Detailed instructions for each task are described following the Quick Reference Guide. The regular maintenance procedures are listed in **Table 1**.

Table 1. Regular maintenance procedures and timing required for the Met One BAM.

Procedure	Timing	Location of Instructions
Replace filter tape as required	Approximately every 2 months	Section 14.1
Flow audit	Every 2 months	Section 14.2
Flow calibration	If flow audit shows >10% difference	Section 10.1
Clean inlet filters (PM ₁₀ /PM _{2.5})	Every 2 months or after rain	Section 14.3
Check and replace carbon vanes in pump	Every 1-2 years	Refer to directions included with pump rebuild kit

14.1 CHANGING THE FILTER TAPE

Refer to Figure 1 for an illustration of the specific components of the Met One BAM 1020 and the correct flow of the tape. The filter tape is the only consumable item for the Met One BAM 1020. One roll should last more than two months under normal operation.



- | | |
|--------------------------------|-----------------------------|
| 1. NOZZLE IN "UP" POSITION | 8. FILTER TAPE |
| 2. CLEAR SPOOL COVER WITH KNOB | 9. SUPPLY SPOOL |
| 3. EMPTY CORE TUBE | 10. SUPPLY TENSION ROLLER |
| 4. TAKE-UP SPOOL | 11. RIGHT END ROLLER |
| 5. PINCH ROLLERS | 12. SAMPLING/MEASURING AREA |
| 6. CAPSTAN SHAFT | 13. LEFT END ROLLER |
| 7. LATCH | 14. TAKE-UP TENSION ROLLER |

14.2 FLOW AUDITS USING THE BIOS FLOWMETER

A flow audit worksheet is provided for zero and full flow through the Met One BAM 1020. The worksheet should be taped into the instrument logbook after each audit.

The reported flow (on the Met One BAM 1020 screen) during normal operation should be 16.7 LPM \pm 0.2 LPM. If the flow during normal operation is within this range, the instrument

is considered to be working properly. If the flows deviate from this range, there is an obstruction or leak. A flow audit should be performed according to the instructions in Section 14.2 of the instrument SOP. This test should be performed at the cyclone when the Met One BAM 1020 inlet is attached (as in normal operation). A manual flow audit can be performed while the instrument is not sampling using the soft-keys Test/ BAM/PUMP/Pump ON. Attach a flow audit adapter to the inlet line (in place of the cyclone) and use the BIOS 40DCL to audit the flow. In all cases, record the initial flowrate at the inlet (where the cyclone is) before proceeding further.

Note: Make sure that a thin layer of high-vacuum grease is applied to the inlet tubing at the cyclone and at its inlet to the instrument before the instrument is set to sample again. Exit the TEST screen by pushing the softkeys PUMPOFF and EXIT. Make sure that the instrument screen displays the main menu.

Methodology:

- Audit the flow at the instrument cyclone.
- If the flow is $\pm 5\%$ of 16.67 LPM, then reaudit the flow at the instrument inlet using a short piece of inlet tubing.
- If the flow is still $\pm 5\%$ of 16.67 LPM, then check the instrument nozzle for deposits. Clean the nozzle using a swab and a solvent.
- Reaudit the flow at the instrument inlet using a short piece of inlet tubing.
- Reaudit the flow at the instrument cyclone.

Note: The instrument flowmeter should only be recalibrated when authorized by Beth Wittig or Nicole Hyslop. The flowmeter recalibration should be performed at the instrument inlet and audited at the cyclone for leaks in the sampling line, prior to setting the instrument back online.

14.3 CHECK WATER/PARTICULATE LOADING IN THE CYCLONES

The Met One BAM 1020 can use a single PM10 cyclone or a compound cyclone that consists of a PM10 cyclone with a PM 2.5 cyclone adapter. Several tasks should be performed to maintain both elements.

15. TROUBLESHOOTING

The Met One BAM 1020 allows for manual operations to isolate subsystems and components for troubleshooting purposes. The various test functions are described in Section 12.1 of the manual. Table 12.1 (of section 10.2) in the manual lists several problems and corresponding solutions for the Met One BAM 1020. The Met One BAM 1020 will also present error flags in each output file. **Table 2** summarizes these error codes.

Task Table 2. Error codes for the Met One BAM data output from the RS-232 port.

Letter	Error ¹
E	Telemetry reset, indicates that the system time was reset; NCAR.
U	Telemetry fault, indicates a fault with the remote telemetry system; NCAR.
M	Met calibration mode, flag is set under the OPERATE/INSTANTANEOUS LCD screen; NCAR.
I	Internal error (divide by zero, etc.); NCAR.
L	Power failure; Make sure unit is on.
R	Reference membrane stuck, membrane motor timed out without completing extension/withdrawal of membrane; Manually check using Test/BAM/CALIBRATION/CONC, notify FM or ME.
N	Nozzle stuck, nozzle motor timed out; Manually test using Test/BAM/PUMP/Nozzle UP and DOWN. Look for deposits on nozzle lip.
F	Flow error, flow <10 or >20 lpm; Perform manual flow audit using Test/BAM/PUMP/Pump ON. If flow is <10LPM, check line to pump for obstructions or crimps in line and pump diaphragm. If Zero flow is greater than 1LPM, check for deposits on nozzle lip. If adjusted span flow with and without extension piece differs by more than 1LPM, retighten extension piece adapter and perform additional flow audit.
P	Pressure error, pressure drops more than 300 mmHg during the cycle or the reference mass flow deviates more than $\pm 5\%$; Check line to pump for breaks in line and leaks in inlet and pump connections to instrument.
D	Deviant membrane density , indicates that the reference membrane was out of limits by more than $\pm 3\%$; NCAR.
C	Count error, any count is <10000; Compare BAM and Aethalometer readings. If the observation was only made by BAM, notify FM or ME and manually check using Test/BAM/CALIBRATION/CONC.
T	Tape error, any tape breakage or tape motor movement error; Check that there is tape and install new roll if needed, check for tears in tape and retape if needed, advance tape several positions and watch movement using Test/BAM/PUMP/Tape Advance.

¹ Key to abbreviations: NCAR = No corrective action required
FM = CRPAQS Field Manager
ME = CRPAQS BAM Measurement Expert

16. DATA ACQUISITION, CALCULATIONS, AND DATA REDUCTION

Once an hour, concentration and flowrate data will be collected from the Met One BAM 1020. Data will be exported from the Met One BAM 1020 through the RS-232 port. This data will be downloaded to STI on a daily basis. NOTE: The LCD screen of the Met One BAM 1020 will not operate when communications over the RS-232 line are in process. If the operator is using the Met One BAM 1020 locally and the display is in one of the sub-menus, the RS-232 data line is disabled. Therefore, the Met One BAM 1020 must be left in the main menu when RS-232 communications are expected.

17. COMPUTER HARDWARE & SOFTWARE

The Met One BAM 1020 saves various setup parameters needed to perform the desired calculations. Once stored, these numbers do not need to be reloaded, even if power is cycled. If any of the instrument parameters change after power cycling, including the time/date, the backup battery may need to be replaced. All of the parameters used in operation of the Met One BAM 1020 are the default values set by the factory. They should never be changed by the operator.

18. DATA MANAGEMENT & RECORDS MANAGEMENT

Met One BAM 1020 particulate concentration and sampling volume values will be downloaded every hour, at the end of each measurement cycle, to the DAS. The Met One BAM 1020 concentration data will be archived, while the flowrate data will only be used for diagnostic purposes.

Task Table 1: Met One BAM 1020 Quick Reference Sheet

(Detailed procedures and troubleshooting for each task follow the Task Table 1 and are listed by task number.)

Task		Frequency	Acceptable Limits	Task Guidance	Troubleshooting Guidance ¹
1	Download data: satellite sites only	Every visit	N/A	Task 1	Task 1
2	Check for instrument errors	Weekly or every site visit	See subtasks	Task 2	See subtasks
2a	Check for errors		No errors		Task Table 2
2b	Check mass concentrations		0.001 - 0.200 mg/m ³ , Typical 0.030 mg/m ³		Task Table 2 (C / F), Task 5, Contact FM or ME
2c	Check for consistency in BAM sampling volumes		±10% of 0.835 m ³ (0.752 - 0.919 m ³)		Task Table 2 (F), Task 5
3	Check instrument settings	Weekly or every site visit.	See subtasks	Task 3	See subtasks
3a	Check flowrate on screen		±10% of 16.7 LPM (15.0 - 18.4 LPM)		Task Table 2 (F), Task 5, Contact FM or ME
3b	Check last calibration measurement		±10% of ABS value (Task Table 3)		Contact FM or ME
3c	Check date and time		± 5 minutes of DAS clock		Reset time/date, Contact FM
3d	Check BAM filter tape supply		>5% w/ DAS, >10% w/o DAS		Task Table 2 (T)
4	System maintenance: Check cyclones and inlet	After rain or monthly	N/A	Task 4	N/A
5	Perform flow audit	monthly	± 5% of 16.67 LPM	Task 5	Task Table 2 (F), Task 5

¹ Key to abbreviations:

FM = CRPAQS Field Manager

ME = CRPAQS BAM Measurement Expert

Required materials:

- Replacement filter paper tape is required and must be changed ~ every 2 months.
- A flow audit adapter is required to audit the flows on the instrument.
- A thermometer and barometer are required to record ambient conditions for the flow audit.
- High vacuum grease for o-ring lubrication.
- Replacement o-rings for cyclone maintenance.
- Inlet cleaning materials (paper towels, cotton-tipped swabs, water, soap).

Task 1: Download data

In order to download data, the instrument must be in the main menu. If the EXIT soft-key function is displayed in the lower right corner of the instrument display, it is not in the main menu. Press the EXIT soft-key until the EXIT function is replaced by the TAPE function.

The RS-232 port is located on the back of the Met One BAM 1020. Attach a serial cable (not a null modem cable) to the COM port of a computer. Open a communications software program such as Hyperterminal.

Use the following settings:	Baud Rate	9600
	Data Bits	8
	Parity	None
	Stop Bit	1.

If the communications are functioning properly, an asterisk should appear on the communications screen when the enter-key is depressed. Start the save or capture function in the communications program to collect the incoming data from the Met One BAM 1020. In the communications screen, enter the number 3. This will download all of the data that was not previously retrieved. If a mistake is made in downloading the data, different commands can be used to retrieve other quantities of data.

- 1 – Display current day data
- 2 – Display all data in memory
- 3 – Display new data that were not previously retrieved
- 4 – Display system configuration
- 5 – Display date/time

If the computer and instrument are not communicating properly, perform the checks listed below. Disconnect the serial cable when the data has been downloaded. The instrument will resume its measurement cycle.

- Check to make sure that the instrument display is in the main menu.
- Check the serial cable and RS232 switch for proper configuration. The Met One BAM 1020 has a switch to allow either a null modem or straight serial cable to be used. The switch is located next to the RS-232 port. If the switch is in the normal position, a null modem cable or adapter must be used. If the switch is in the reverse position, a straight cable must be used. Make sure that the proper combination is being used.
- If the communications still do not work, call STI.

Task 2: Check data output**Task 2a:** Check for errors in data output

Task Figure 1 below shows an example of the data format from the RS-232 port. The second column of the data is reserved for error reporting. If a letter replaces any of the dashes, an error occurred during that cycle. In the second cycle, the D indicates that a calibration error occurred. Calibration (D) errors are commonly encountered as a result of modifications to the instrument for the CRPAQS field study. The errors are summarized in **Task Table 2**.

Task Figure 1. Example of a typical data report from the RS-232 port.

Sensor Units	(Errors)	Conc mg	Channel 01		02	03	04	05	06
			Qtot m3	XXX XXX	XXX XXX	XXX XXX	XXX XXX	XXX XXX	XXX XXX
00:00	-----	0.011	0.835	0.000	0.000	0.000	0.000	0.000	0.000
01:00	-----D--	0.016	0.830	0.000	0.000	0.000	0.000	0.000	0.000
02:00	-----	0.016	0.830	0.000	0.000	0.000	0.000	0.000	0.000

Task 2b: Check mass concentrations in data output

The mass concentrations are listed in the third column of the data output. The column is incorrectly labeled as having units of mg; the correct units are mg/m^3 . The mass concentrations should be between 0.000 and 0.200 mg/m^3 . The concentrations in Bakersfield have been close to 0.030 mg/m^3 most of the time.

Task 2c: Check for consistency in Met One BAM 1020 sampling volumes

The sampling volumes are listed in the fourth column of the data output. The volumes can vary by up to 10%, but they should not change by more than $\pm 0.050 \text{ m}^3$. A smaller trend ($\pm 0.015 \text{ m}^3$) may result from changing atmospheric pressures. If there is a more significant trend in the sampling volume data, contact STI.

Task Table 2. Error codes for the Met One BAM data output from the RS-232 port.

Letter	Error ¹
E	Telemetry reset, indicates that the system time was reset; NCAR.
U	Telemetry fault, indicates a fault with the remote telemetry system; NCAR.
M	Met calibration mode, flag is set under the OPERATE/INSTANTANEOUS LCD screen; NCAR.
I	Internal error (divide by zero, etc.); NCAR.
L	Power failure; Make sure unit is on.
R	Reference membrane stuck, membrane motor timed out without completing extension/withdrawal of membrane; Manually check using Test/BAM/CALIBRATION/CONC, notify FM or ME.
N	Nozzle stuck, nozzle motor timed out; Manually test using Test/BAM/PUMP/Nozzle UP and DOWN. Look for deposits on nozzle lip.
F	Flow error, flow <10 or >20 lpm; Perform manual flow audit using Test/BAM/PUMP/Pump ON. If flow is <10LPM, check line to pump for obstructions or crimps in line and pump diaphragm. If Zero flow is greater than 1LPM, check for deposits on nozzle lip. If adjusted span flow with and without extension piece differs by more than 1LPM, retighten extension piece adapter and perform additional flow audit.
P	Pressure error, pressure drops more than 300 mmHg during the cycle or the reference mass flow deviates more than $\pm 5\%$; Check line to pump for breaks in line and leaks in inlet and pump connections to instrument.
D	Deviant membrane density , indicates that the reference membrane was out of limits by more than $\pm 3\%$; NCAR.
C	Count error, any count is <10000; Compare BAM and Aethalometer readings. If the observation was only made by BAM, notify FM or ME and manually check using Test/BAM/CALIBRATION/CONC.
T	Tape error, any tape breakage or tape motor movement error; Check that there is tape and install new roll if needed, check for tears in tape and retape if needed, advance tape several positions and watch movement using Test/BAM/PUMP/Tape Advance.

¹ Key to abbreviations: NCAR = No corrective action required
FM = CRPAQS Field Manager
ME = CRPAQS BAM Measurement Expert

Task 3: Check the instrument settings

Task 3a: Check the flowrate on the instrument screen

The flowrate is displayed on the Main Menu/OPERATE/NORMAL screen and is labeled “FLOW”. (Note: The Main Menu will have the function “TAPE” on the right soft-key. Press the EXIT soft-key until the EXIT function is replaced with the TAPE function to return to the Main Menu.) The FLOW value can only be viewed when the pump is operating. The pump is only on from ~5 minutes after the hour to ~56 minutes after the hour.

If the pump is not on, it can be manually activated from the Main Menu using the soft-keys TEST/BAM/PUMP/Pump ON. Note: The Main Menu will have the function “TAPE” on the right soft-key. The use of the TEST functions aborts the current hour of sampling. The next sampling period will not take place until the beginning of the next hour. As a result, the TEST function should only be used to test the pump if there is a real concern.

Record the FLOW value on the worksheet. Stay in this screen to perform the next task.

Task 3b: Check the last calibration measurement on instrument screen

The last calibration value is displayed on the Main Menu/OPERATE/NORMAL screen and is labeled “LAST m”. (Note: The Main Menu will have the function “TAPE” on the right soft-key. Press the EXIT soft-key until the EXIT function is replaced with the TAPE function to return to the Main Menu.) Record the LAST m value on the worksheet. Press the EXIT soft-key twice to return to the main menu.

The values should be within $\pm 10\%$ of the ABS value for that instrument. The ABS values for each of the instruments is listed below according to the Met One serial numbers. If the values are not within the acceptable range, call STI.

Task Table 3. ABS values for each of the Met One BAM 1020 instruments.

Met One serial number	ABS value	Acceptable Range for last m value
009	0.188	0.169-0.207 mg/cm ²
010	0.173	0.156-0.190 mg/cm ²
024	0.186	0.167-0.205 mg/cm ²
027	0.162	0.146-0.178 mg/cm ²
028	0.217	0.195-0.239 mg/cm ²

Task 3c: Check the date and time on instrument display

The date and time are displayed on the Main Menu screen. (Note: The Main Menu will have the function “TAPE” on the right soft-key. Press the EXIT soft-key until the EXIT function is replaced with the TAPE function to return to the Main Menu.)

If the date or time is not correct within ± 5 minutes of a time standard, then the settings should be adjusted. Note that when the SETUP menu is entered, the instrument will stop operating (i.e. the pump will turn off.). To change the date and time, select the Main Menu/CLOCK screen. Use the up and down arrow keys to adjust the time or date. Press the SAVE and EXIT soft-keys to finalize the changes. Record any changes on the worksheet and in the instrument log.

Task 3d: Check amount of Met One BAM 1020 filter tape supply

The Met One BAM 1020 filter tape supply should be checked every time the site is visited. Normally, a single roll of filter tape should last more than two months. Use a marker or pen to mark the position on the used tape each time to keep track of the tape usage. Note that clean gloves should be worn when handling the unused filter tape.

When there is less than 5% (anchor sites) or 10% (satellite sites) of filter tape remaining, replace the tape using the following directions. Refer to **Task Figure 3** for an illustration of the specific components of the Met One BAM 1020 and the correct spooling of the tape.

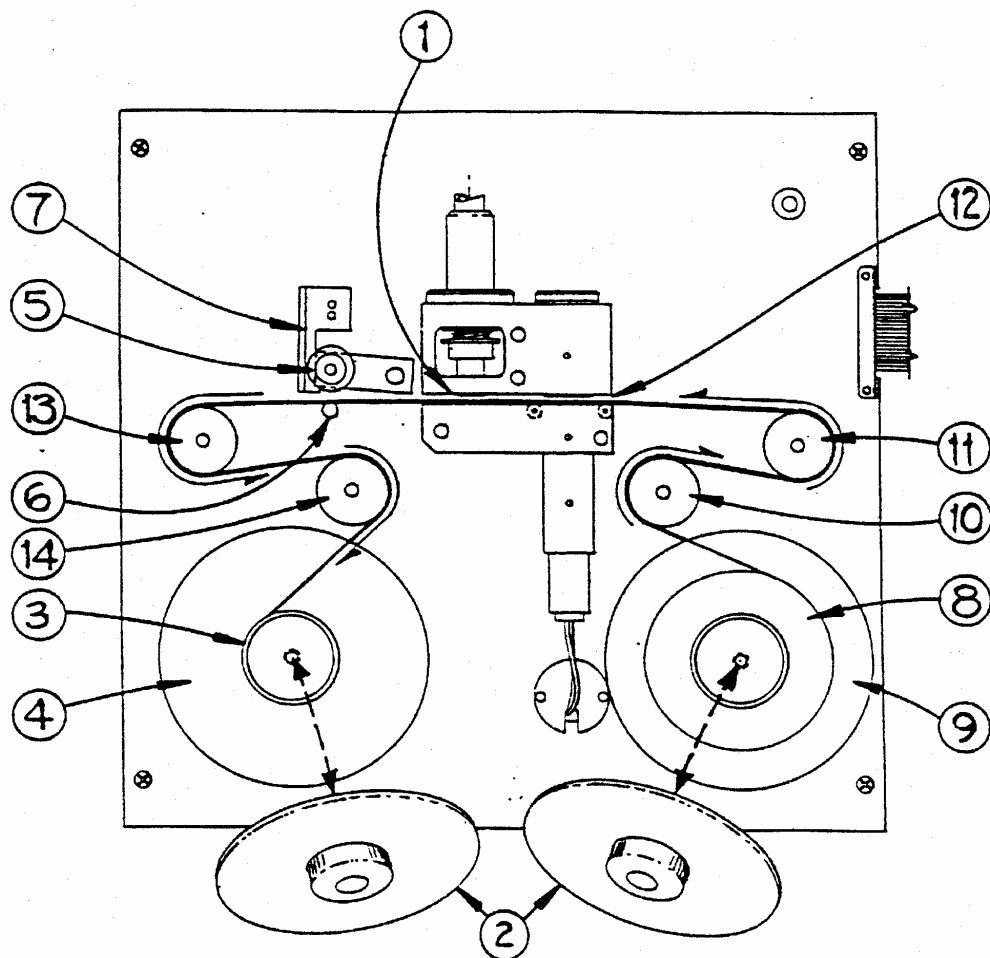
- Select the Main Menu/TAPE screen. (Note: The Main Menu will have the function “TAPE” on the right soft-key. Press the EXIT soft-key until the EXIT function is replaced with the TAPE function to return to the Main Menu.) Three new functions should be associated with the soft-keys in the TAPE screen: TENSION, SELF TEST, and EXIT.
- Press TENSION to verify that the nozzle is in the up position. When the nozzle is in the up position, there will be a gap of approximately $\frac{1}{4}$ inch between the surface of the tape and the bottom of the nozzle.
- Lift the end of the roller shaft to lift the pinch roller off of the tape. Use the latch to the left to hold the pinch roller away from the tape.
- Remove the clear plastic tape holders from the take-up and supply tape rolls by unscrewing the center knobs. Manually feed the unused filter tape onto the take-up spool from the supply spool until the supply spool is empty. If a lot of filter tape remains on the supply spool, cut the filter tape near the supply spool and manually feed the shortened tape length onto the take take-up spool.
- Remove the filter tape from the take-up spool, retain the cardboard core tube, and discard the used tape. **Important:** One of the core tubes must be used as the new take up spool.
- Place the empty cardboard core tube on the take-up spool.

- Put on clean gloves and place the full roll of filter tape on the supply (right) spool and thread the tape through the various spools as shown in Task Figure 3.
- Using adhesive tape, attach the leading end of the filter tape to the core tube.
- Install both clear plastic tape holders.
- Gently lower the pinch-rollers by releasing the latch to the left while supporting the end of the roller shaft.
- Check for proper installation of the tape by pressing the TENSION soft-key.
- If there is an error, check to make sure that the tape is properly threaded around the various spools, that the tape is securely attached to the take-up spool, and that the latch has been lowered is not holding the pinch-rollers off of the tape. If any changes are made, press TENSION again.
- When there are no errors, press the SELF TEST soft-key. Approximately 60 seconds are required for the SELF TEST to be completed. Confirm that the SELF TEST results are as listed in Task Figure 2.

Task Figure 2. Successful SELF TEST results.

LATCH: OFF	APE BREAK: OK
CAPSTAN: OK	APE TENSION: OK
NOZZLE DN: OK	SHUTTLE: OK
DOZZLE UP: OK	REF EXTEND: OK
FLOW: OK	REF WITHDRAWAL: OK
Status: SELF TEST PASSED	

- If one of the tests fails, refer to Section 4.9 of the instrument manual for specific descriptions of each of the tests.
- If the results of the self-test are all correct, press EXIT to return to the main screen. The Status of the instrument should be ON, indicating that the instrument has returned to the operating mode. If it is not ON, select the Main Menu/OPERATE/NORMAL screen. Use the arrow keys to turn the STATUS function to “ON”.



- | | |
|--------------------------------|-----------------------------|
| 1. NOZZLE IN "UP" POSITION | 8. FILTER TAPE |
| 2. CLEAR SPOOL COVER WITH KNOB | 9. SUPPLY SPOOL |
| 3. EMPTY CORE TUBE | 10. SUPPLY TENSION ROLLER |
| 4. TAKE-UP SPOOL | 11. RIGHT END ROLLER |
| 5. PINCH ROLLERS | 12. SAMPLING/MEASURING AREA |
| 6. CAPSTAN SHAFT | 13. LEFT END ROLLER |
| 7. LATCH | 14. TAKE-UP TENSION ROLLER |

Task 4: System maintenance - Check cyclones and inlet

The Met One BAM 1020 uses a compound cyclone that consists of a PM₁₀ cyclone with or without a PM_{2.5} cyclone adapter. Perform the following tasks to maintain both cyclones.

Task 4a: PM₁₀ cyclone

- Disassemble the upper and lower inlet halves by unscrewing the two pieces counter-clockwise. Mark the top plate deflector cone and lower plate with a pencil to allow for easier reassembly. Remove the four pan head screws from the top plate, lift the top plate, and set aside. Remove the insect screens from the lower plate assembly.
- Inspect and clean the insect screen by rinsing with water. Dry and reinstall.
- Inspect and clean the acceleration nozzle. Use a cotton swab and soapy water to remove contamination from the acceleration nozzle. Inspect the large diameter impactor nozzle o-ring for wear (brittle or cracked). Replace, if necessary, and apply a thin film of high vacuum grease to the o-ring and aluminum threads. Reinstall the insect screen, align the top plate with the lower plate markings, insert and retighten the four pan head screws.
- Inspect and clean the lower collection plate. This is where most of the contamination will be found. Use a cotton paper towel/swab and soapy water to clean the collector assembly walls, vent tubes, and bottom side of the collector assembly.
- Inspect and clean the weep hole and moisture trap. The weep hole is where moisture runs out to the moisture trap; Use a cotton swab to clean this. The moisture trap is the glass jar for collecting water or particulate matter; If the moisture trap is filled (<50%), unscrew it from the cover, dump out any water, wipe it clean with a towel, apply a thin layer of high vacuum grease on the cork gasket inside of the cap, and reattach it.
- Inspect the o-rings at the part of the cyclone that attaches to the inlet tubing. Check that the o-rings are not dry, brittle, or cracked. If they are simply dry, place a thin layer of high vacuum grease on the PM_{2.5} cyclone adapter where it fits into the PM₁₀ cyclone. If the o-rings are brittle or cracked, replace them.
- Reassemble the top and bottom inlet halves carefully to hand-tight. Apply a thin layer of high vacuum grease to the section of the inlet tubing that fits into the cyclone.
- Replace the cyclone on the inlet tube.

Task 4b: PM_{2.5} cyclone adapter

The PM 2.5 cyclone adapter has two stainless steel sections that should be removed and cleaned. The sections are located on opposite sides of the cyclone.

- The first section is a small plug that can be unscrewed by hand. Wipe dust from the small plug with a towel.

- The other section is a vertical arm attached to the main body at two points. This section is secured with gaskets and must be pulled off with a back and forth action. Once this piece is removed, there is another plug at the top junction point that must be unscrewed. Both of these pieces should be cleaned with a towel.
- Check that the o-rings are not dry, brittle, or cracked. If they are simply dry, place a thin layer of high vacuum grease on the section of the adapter where the o-rings are before reassembling the system. If the o-rings are brittle or cracked, it is likely that they will leak. Replace them and then apply a thin layer of high vacuum grease on the section of the adapter where the o-rings are before reassembling the system.

Task 5: Perform flow audit

The reported flow (on the Met One BAM 1020 screen) during normal operation should be 16.7 LPM \pm 0.2 LPM. If the flow during normal operation is within this range, the instrument is considered to be working properly. If the flows deviate from this range, there is an obstruction or leak. A flow audit should be performed according to the instructions given below. This test should be performed at the cyclone when the Met One BAM 1020 inlet is attached (as it is during normal operation).

A manual flow audit can be performed while the instrument is not sampling using the soft-keys Main Menu/TEST/BAM/PUMP/Pump ON. (Note: The Main Menu will have the function "TAPE" on the right soft-key. Press the EXIT soft-key until the EXIT function is replaced with the TAPE function to return to the Main Menu.) Attach a flow audit adapter to the inlet line (in place of the cyclone) and use the BIOS 40DCL to audit the flow. **Important:** Use a BIOS 40DCL or another primary flow standard to perform this task. If a primary flow standard is not available, then contact STI and **do not** perform this task until one is available.

Record the initial flowrate at the inlet (where the cyclone is) before performing the audit. When the flow audit is complete, make sure that a thin layer of high-vacuum grease is applied to the inlet tubing at the cyclone and at its inlet to the instrument before the instrument is set to sample again. Make sure that the instrument screen displays the Main Menu screen when the audit is completed.

Methodology:

- Audit the flow at the instrument cyclone by setting the flow audit adapter to zero flow.
- If the flow is > 1 LPM, reaudit the flow at the instrument inlet using a short inlet.
- If the flow is still > 1 LPM, check the instrument nozzle for deposits. Clean the nozzle using a swab and a solvent. Call STI for assistance if needed. Reaudit the flow at the instrument inlet using a short inlet.

- If the zero flow audit at the instrument is successful, reaudit the flow at the instrument cyclone.
- If the zero flow audit at the cyclone is successful, perform a full flow audit at the cyclone in accordance with the procedures given below.

Note: The instrument flowmeter should only be recalibrated if authorized by the Field Manager or the Measurement Expert. The flowmeter recalibration should be performed at the instrument inlet and audited at the cyclone for leaks in the sampling line, prior to setting the instrument online.

Typical flow problems:

- If the zero flow is greater than 1 LPM: Check for deposits on nozzle lip. Remove the deposits using ethanol and a cotton-tipped swab. Do not use a blade.
- If the flow is less than 16 LPM: Check the line to the pump for obstructions or crimps. If there are no obstructions at this point, check the pump (diaphragm).
- If the flows deviate more than ± 0.2 LPM from the last setpoint (which should have been 16.7 LPM): Check and reapply the grease on the inlet at the cyclone. Retighten the adapter that joins the 2 extension pieces together.

Flow audit procedures:

Fill out the Task 5 worksheet each time a flow audit is performed and archive the worksheet. Manually turn the instrument pump on from the Main Menu screen by selecting Main Menu/TEST/BAM/PUMP/Pump ON.

Task 5a: Record the primary flow standard information

Task 5b: Record the current ambient conditions

Record the current temperature and pressure using an external thermometer and barometer if available. Convert the measurements to K and mmHg.

$$T (K) = T (C) + 273.15$$

$$P (\text{mmHg}) = P (\text{inHg}) \times 25.4 = P (\text{mb}) \times 0.75$$

Task 5c: Calculate the Ratio of STP to ambient conditions

Use the STP conditions for the BAM mass flow meter and the current temperature and pressure. STP for the Met One 1020 BAM is 298K and 760 mmHg.

Ratio of STP to ambient conditions = $298K \times P \text{ (mmHg)} / T \text{ (K)} / 760 \text{ (mmHg)}$

Task 5d: Record the time when the audit was started

Task 5e: Record several instrument flowrates (as seen on the instrument display)

Flow with cyclone – Record the instrument flow before removing the cyclone(s).

Flow with BIOS attached – Remove the cyclone and attach the flow audit adapter. To attach the BIOS, remove the cyclone(s), put a new thin layer of grease on the adapter, attach the audit adapter to the inlet, and attach a BIOS hose to the audit adapter. Place the BIOS on a horizontal surface level with the top of the inlet, making sure that the BIOS hose does not crimp. You can use a ladder. Record the instrument flow after this has been done.

Flow with adapter set to zero – Adjust the audit adapter valve to stop air-flow to the instrument. When a stable reading is obtained, record the instrument flowrate.

Task 5f: Record several BIOS flowrates (as seen on the BIOS display)

Adjust the valve on the audit adapter to allow air to flow to the instrument. Press and hold the STOP/RESET key on the BIOS until the BIOS screen shows:

```
Flow>      L      OFF
Average>    L      #
      Number in Average ^
```

Press and hold the READ/AUTO key on the BIOS until you can hear the flow cell moving up and down. Allow the BIOS to count through several 1-10 sequences. When value3 reaches "10" again, write down value2 on the flow audit worksheet, where value1 is the current flowrate (LPM), value2 is the current average flowrate (LPM), and value3 is the current measurement number (out of 10) used to calculate value2.

```
Flow>      value1
Average>    value2  value3
      Number in Average ^
```

Repeat this for 9 more cycles and fill out the worksheet. Reset the BIOS. Reattach the cyclone to the inlet. Remove the audit adapter, wipe off the inlet tubing, apply a thin layer of high vacuum grease to the instrument inlet, and reattach the cyclone.

Take the instrument out of test mode by selecting Pump OFF/EXIT. This will return the BAM to the Main Menu.

Task 5g: Record the time when the instrument was returned to the Main Menu

Task 5h: Compare BAM to BIOS

SOP: Met One BAM 1020

Revision: 4.1 (MM)

Date: October 26, 2000

Average BIOS flow = Sum of the 10 BIOS readings / 10

Average adjusted BIOS flow = Average BIOS flow x Ratio of STP to ambient

Delta = Average adjusted BIOS flow - Instrument flow with BIOS attached

% Difference = Delta / Average adjusted BIOS flow

Task 5i: Compare BAM to Setpoint

Flowrate setpoint for BAMs = 16.67 LPM

Current BAM flowrate = Instrument flow with cyclone attached (Task 5e)

BAM flowrate \pm 0.5 LPM of setpoint = Flowrate setpoint - Current BAM flowrate

Task 5j: Comments

Update the logs:

- Site log – Record the online and offline time. Note in the comment section that a flow audit was being performed.
- Instrument log – Record the online and offline time. Note that a flow audit was being performed.

SOP: Met One BAM 1020

Revision: 4.1 (MM)

Date: October 26, 2000

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Instrument:	Met One 1020 Beta Attenuation Monitor (BAM)
Worksheet:	Task 1 - Download data: Satellite sites only (every visit) Task 2 - Check for instrument errors (weekly) Task 3 - Check instrument settings: TEST values (weekly)
Site Code:	

Date	/ /	/ /	/ /
Field Tech			
Instrument SN			
Cyclone sizecut	PM _{2.5} / PM ₁₀	PM _{2.5} / PM ₁₀	PM _{2.5} / PM ₁₀
INITIAL CHECKS:			
Time			
DAS clock (PST)	: :	: :	: :
BAM clock (PST)	: :	: :	: :
1.) DOWNLOAD DATA: SATELLITE SITES ONLY			
Data start time	: :	: :	: :
Data stop time	: :	: :	: :
Comments			
2.) CHECK FOR INSTRUMENT ERRORS:			
Data review start date (PST)	/ /	/ /	/ /
Data review stop date (PST)	/ /	/ /	/ /
Any errors?	Yes / No	Yes / No	Yes / No
Comments Note error type, date, and time.			
Parameter	Acceptable range		
Mass conc value / Acceptable?	0.001 - 0.200 mg/m ³	/ Yes / No	/ Yes / No
Sampling vol value / Acceptable?	0.752 - 0.919 m ³	/ Yes / No	/ Yes / No
Comments Note out-of-range values, date, and time.			
3.) CHECK INSTRUMENT SETTINGS:			
Parameter	Acceptable range		
Settings:			
Last calib value / Acceptable?	± ABS value mg/m ²	/ Yes / No	/ Yes / No
Current time / Acceptable?	± 5 DAS mins	/ Yes / No	/ Yes / No
New time / Changed?	N/A	/ Yes / No	/ Yes / No
Filter tape remain / Acceptable?	> 5% (Anchor sites)	/ Yes / No	/ Yes / No
	> 10% (Satellite sites)		
Comments			
Maintenance:			
Filter changed?	N/A	Yes / No	Yes / No
Roof inlet checked?	N/A	Yes / No	Yes / No
Water jar checked? / Emptied?	N/A	Yes / No / Yes / No	Yes / No / Yes / No

Instrument:	Met One 1020 Beta Attenuation Monitor (BAM)
Worksheet:	Task 4 - System maintenance: Check cyclones / inlet (monthly / after rain) Task 5 - Perform flow audit (monthly)
Site Code:	

Date	/ /	/ /	/ /
Field Tech			
Instrument SN			
Cyclone sizecut	PM _{2.5} / PM ₁₀	PM _{2.5} / PM ₁₀	PM _{2.5} / PM ₁₀
INITIAL CHECKS:			
Time			
DAS clock (PST)	: :	: :	: :
BAM clock (PST)	: :	: :	: :
4.) SYSTEM MAINTENANCE: CHECK CYCLONES AND INLET			
Start time	: :	: :	: :
Stop time	: :	: :	: :
Cleaned PM _{2.5} cyclone?	Yes / No	Yes / No	Yes / No
Cleaned PM ₁₀ cyclone?	Yes / No	Yes / No	Yes / No
Emptied PM ₁₀ water jar?	Yes / No	Yes / No	Yes / No
5.) PERFORM FLOW AUDIT:			
Flow audit formula			
T (K) = T (C) + 273.15 P (mm Hg) = P (in Hg) x 25.4 = P (mb) x 0.75 Ratio of STP to ambient conditions = 298 x P (mm Hg) / 760 / T (K) Adjusted average BIOS flow (LPM) = Average BIOS flow (LPM) x Ratio of STP to ambient conditions Delta (LPM) = Adjusted average BIOS flow (LPM) - Instrument flowrate with BIOS attached (LPM) % Difference (%) = 100 x Delta (LPM) / Adjusted average BIOS flow (LPM)			
5a.) BIOS model / SN	40DCL /	40DCL /	40DCL /
5b.) Ambient conditions			
Temperature (C) / Temperature (K)	/	/	/
Pressure (in Hg or mb) / Pres. (mm Hg)	/	/	/
5c.) Ratio of STP to ambient conditions			
5d.) Start date (PST) / Time	/	/	/
5e.) Instrument flowrates (LPM)			
Flow with cyclone (LPM)			
Flow with BIOS attached (LPM)			
Flow with adaptor set to zero (LPM)			
5f.) BIOS flowrates (LPM) / Time			
1 st BIOS flow (LPM) / Time	/	/	/
2 nd BIOS flow (LPM) / Time	/	/	/
3 rd BIOS flow (LPM) / Time	/	/	/
4 th BIOS flow (LPM) / Time	/	/	/
5 th BIOS flow (LPM) / Time	/	/	/
6 th BIOS flow (LPM) / Time	/	/	/
7 th BIOS flow (LPM) / Time	/	/	/
8 th BIOS flow (LPM) / Time	/	/	/
9 th BIOS flow (LPM) / Time	/	/	/
10 th BIOS flow (LPM) / Time	/	/	/
5g.) Stop date (PST) / Time	/	/	/
5h.) Compare BAM to BIOS			
Average BIOS flow (LPM)			
Adjusted average BIOS flow (LPM)			
Delta (LPM)			
% Difference (%)			
5i.) Compare BAM to Setpoint			
Flowrate setpoint for BAMs	16.67 LPM	16.67 LPM	16.67 LPM
Current BAM flowrate (LPM)			
BAM flowrate ± 0.5 LPM of setpoint?	Yes / No	Yes / No	Yes / No
5j.) Comments			